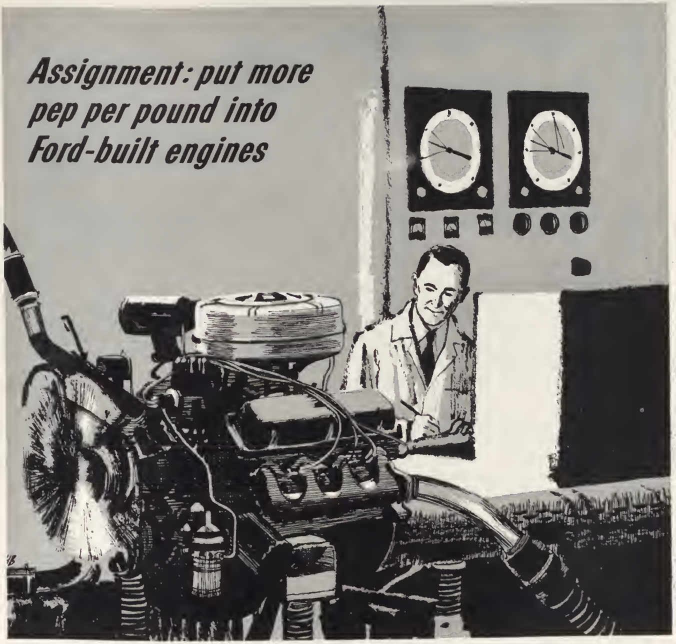
the Mechelec iv

VOLUME 21 April - 1963 No. 5

THE GEORGE WASHINGTON UNIVERSITY

APRIL 1963



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Editorial Comment

Student-Faculty Forum

Professor Louis dePian recently introduced to a group of seniors an educational approach previously unavailable here. He suggested that a student-faculty discussion or forum be initiated for the purpose of obtaining comprehensive answers to student's technical questions. A round table approach to education is not new since it has been used for centuries at many institutions.

The avowed purpose of the forum would be to provide a means for diversifying the educational process. A relaxed atmosphere will minimize the student-teacher relationship and encourage a more liberal exchange of ideas. Several faculty members will be present so that different disciplines can be treated with equal competence. In order to maintain maximum interest and utility, questions will be limited to those disciplines of concern to advanced students. It is hoped that the spontaneous questions will be relatively comprehensive, and that restricted questions will be submitted in advance so that greater applicability may be achieved.

One important consideration is that this type of gathering will be of interest only to those students sincerely desiring to broaden their educational backgrounds. Those students interested only in obtaining a degree and not the advantages offered by the university community will certainly not be interested. However, those students wishing to benefit more fully while they obtain a degree will find that the forum will provide an opportunity for them to derive greater benefit from the university atmosphere.

Mecheleciv feels that a real opportunity for a more complete education will be lost if students do not support the forum whole-heartedly. It will provide students with an opportunity for obtaining answers to specific questions and an understanding of basic problems connected with other disciplines. The first impulse has been provided by the faculty and a concerted effort will be made to maintain an informal attitude. The atmosphere will promote combined intellectual curiosity, with two or three of the group answering the questions because of their greater knowledge in a specified area.

It is significant that the idea was proposed by a faculty member with the stipulation that students must prove their interest by their attendance. The forums will be operated on a trial basis this spring and will be continued next fall only if sufficient interest is shown. Professor dePian firmly believes that the faculty cannot refuse to provide such a service if the students demand it. In addition, the possibility of expansion to include another meeting of interest to students in the introductory level will be provided if so desired. This meeting could be moderated by advanced level or graduate students and would not involve the level of sophistication of the advanced forum.

Page nineteen of this issue contains information pertaining to the time and location of the first forum. Students must indicate interest by their attendance if the forums are to continue. If this most worthwhile venture is given careful consideration by all students, the result can be none other than a resounding success.

—D.L.J.

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VOLUME 21 April - 1963 No. 5

ARTICLES

DEPARTMENTS

This month's cover depicts the measurement of force by the use of Newton's Third Law. The photograph was taken from an exhibit by the National Bureau of Standards on the State of the Art of Measurement.

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Second class postage paid at Washington, D. C. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C., or telephone FEderal 8-0250, Ext. 528.

Subscription Price: Two Dollars

CHANGE OF ADDRESS: Send your new address at least 30 days before the date of the issue with which it is to take effect.

The authors of this article were the two people most responsible for the success of Engineers' Week. Both of them are electrical engineering students and both have been active on the Engineers' Council. Phil was Engineers' Open House Chairman and he is a member of the IEEE and Phi Sigma Delta Fraternity. He plans to graduate in June and continue employment at the Harry Diamond Laboratories. Richard was the IRE representative to the Engineers' Council and he is also a member of IEEE. He plans to graduate next February.

ENGINEERS'

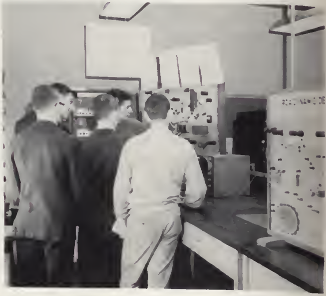
Again this year the students of the School of Engineering and Applied Science, under the sponsorship of the Engineers' Council, successfully completed the Engineers' Week activities. Attendance this year approximately doubled last year's 500 visitors and student participation was increased considerably.

Industrial participation kept pace by providing a greater variety of interesting exhibits. The participation by all factors indicates a growing usefulness and success of the Engineers' Week publicity.

The activity has grown tremendously since its origin as Parents' Day a few years ago. The first Parents' Day was sponsored by the faculty and received somewhat modest attendance. Two years ago the faculty cooperated with the Engineers' Council in introducing the purpose of Engineering and Engineering education to approximately 100 visitors. Last year, Engineers' Days became the sole responsibility of the Engineers' Council which responded by providing many exhibits and student projects for the visitor's enlightenment.

This year, Engineers' Week was held in conjunction with National Engineers' Week, February 18 through 23, and it was nominally sponsored by the National Society of Professional Engineers. The main purpose of Open House was to interest high school students in a career in

Visitors observing one of the many informative exhibits.


Harvey Flatt explains one of the demonstrator boards in the electronics laboratory.

science or engineering. Throughout the entire planning of this year's Engineers' Open House, three main factors were emphasized. These factors were publicity, exhibits, and student participation. Over 500 letters were sent to various science clubs and groups within the metropolitan area. Positive responses from as far away as Havre de Grace, Maryland, supported the theory that the interest needed only the stimulus. The Engineers' Council, in coordination with the university's Public Relations Department, sent literature to all the local newspapers, radio and television stations. Two of the newspapers, many of the radio stations and two of the television stations covered our event. Private industrial and governmental agencies were contacted, informed of the purpose of Engineers' Week, and invited to participate. Most firms responded to the invitation by submitting a model or system exhibit. As visitors to the event will attest, many of these exhibits demonstrated a highly refined degree of precision and certainly all were informative. The students and staff of the School of Engineering and Applied Science were called upon to devise experiments and to man the exhibits. This they did with much enterprise and enthusiasm. Student participation carried the bulk of Engineers' Week to the visitors. The main point stressed was what we the students and faculty of the School of Engineering and Applied Science were doing. Members of the engineering societies, IEEE, ASCE and ASME, devised student exhibits. A high opinion of their

WEEK - 1963

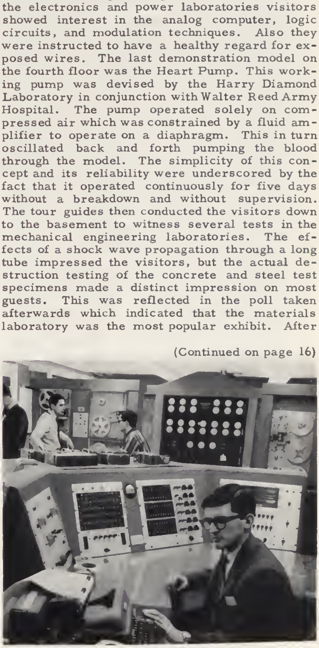
by Richard Shearer and Phil Waleoff

The new hydraulic Universal Testing Machine.

effort was reflected in the votes cast for these student exhibits.

Incoming guests were met in the lobby, and invited to sign the guest register. Since many visitors were young people, and since they sometimes came in quite sizable groups, all of them did not sign the register. In spite of this a record number of visitor signatures (609) were registered and an estimated 1,000 guests were admitted. In Room 102 the visitors were confronted with their own image on a closed circuit television system provided by Video Engineering, Inc. In the same room was an animated display by the Applied Physics Laboratory of Johns Hopkins University, featuring the ANNA Geodetic Satellite, a high intensity light source placed in orbit to facilitate more accurate measurements of distances on earth using triangulation methods. In the corridor a display by the National Bureau of Standards showing the state of the art of measurement encompassed most of the recent developments in that field. In Room 200 guests saw two futuristic water vehicles, hydrofoil and hydroplane models loaned by the Bureau of Ships. In the same room was an anti-submarine warfare exhibit by Vitro Engineering, Inc., which outlined the projected developments in that area of defense. Further along on the second floor the army exhibited a model of the Camp Century arctic base which is a self contained atomic-powered underground geological base under the polar snow cap. After a climb to the fourth floor, the visitors witnessed, or rather heard, a voice modulated transmission from one end of the corridor to the other. The message was sent out and received over two helical antennas, a product of the electrical engineering project laboratory. In the electronics and power laboratories visitors showed interest in the analog computer, logic circuits, and modulation techniques. Also they were instructed to have a healthy regard for exposed wires. The last demonstration model on the fourth floor was the Heart Pump. This working pump was devised by the Harry Diamond Laboratory in conjunction with Walter Reed Army Hospital. The pump operated solely on compressed air which was constrained by a fluid amplifier to operate on a diaphragm. This in turn oscillated back and forth pumping the blood through the model. The simplicity of this concept and its reliability were underscored by the fact that it operated continuously for five days without a breakdown and without supervision. The tour guides then conducted the visitors down to the basement to witness several tests in the mechanical engineering laboratories. The effects of a shock wave propagation through a long tube impressed the visitors, but the actual destruction testing of the concrete and steel test specimens made a distinct impression on most guests. This was reflected in the poll taken afterwards which indicated that the materials laboratory was the most popular exhibit. After

(Continued on page 16)



Richard Shearer at the console of FLAC II.

PNEUMATIC COMPUTERS - A NEW APPROACH

by Douglas Jones

Progress in the field of digital computers in the past decade has been truly remarkable. One such advancement is the pneumatic digital computer. The scope of engineering in the future may be greatly affected by this computer if it fully realizes its potential in many widespread applications. The major feature of the pneumatic computer is a bistable, or flip-flop, element that operates on a compressed gas. This computer is similar to an electronic digital computer in many ways. However, there are several features of the pneumatic computer that are uncommon to the electronic computer and may be more useful in some applications. These advantages include a wider temperature range, denser packaging, and simplicity of the power supply.

Digital circuitry depends on a signal timing and duration, not on magnitude. For this reason the effects of non-linearities and non-precise power supply regulation pose no problem in digital pneumatic computers. The heart of the computer is the instrumentation of a pneumatic diode and the bistable amplifier. In pneumatic circuitry, a diode is an orifice operating above critical flow, i.e. gas flowing through the throat at or above the speed of sound. Since a pneumatic resistance is an orifice or capillary, the instrumentation of diode logic circuits involve the appropriate interconnection of orifices and capillaries of various sizes.

The basic bistable element composes the memory of the computer. It consists of a small ball that can be stable in either of two positions depending upon the external conditions affecting it. The ball moves freely, but not loosely, in a cylindrical housing having four tubular connections, as shown in Figure 1. The connections 1 and 2 are supplied through separate flow restricting orifices by a common pneumatic supply at a pressure P_s. The connections 3 and 4 are open to the atmosphere.

The forces on the ball are the resultant of: (1) P_s acting on the area of the seat opening and

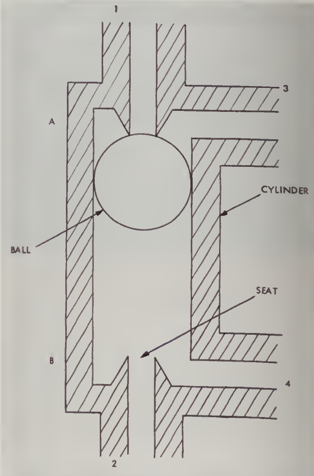
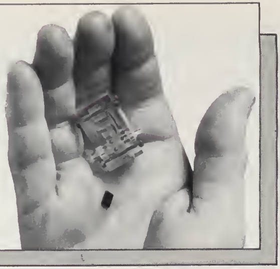


Fig. 1

tending to force the ball away from A (see Figure 2); (2) the pressure in the cylinder acting on the entire ball area, urging the ball toward A, and (3) a very small pressure on the ball area less the seat area due to the back pressure at 3, tending to force the ball away from A. The switching time of the ball is ten millionths of a second.

The output of the device can be taken as the pressure drop across the supply orifices, where the orifices in this case are analogous to the load resistors in a vacuum tube circuit. The gain may be defined as the ratio of the drop across the supply orifice to the magnitude of the



Tiny black box performs the same functions as the transparent laboratnry model of a pneumatic computer module i.e., six flip-flops. Designers expect to reduce the size of the module even more. Elements can be packaged to a density of 2,000 to 4,000/cubic inch.

input pressure, and is controlled by installing flow restrictions in branches 3 and 4 of the bistable element. The bistable element operates in terms of pressure differentials, and does not require overly accurate control of the supply pressure, temperature, or leakage. A possible gain of a stage may be approximately 100.

Another advantage of this computer is that pneumatic signals are converted to electrical signals by simple methods. This is done by sensing the movable ball by means of a coil, or capacitor plates, in the walls of the cylinder.

Because of the temperature sensitivity of modern semi-conductors in electronic computers many difficulties are encountered, mainly in the area of the heat capacities of the devices and thermal runaway. The pneumatic computer would be able to operate in temperatures ranging from

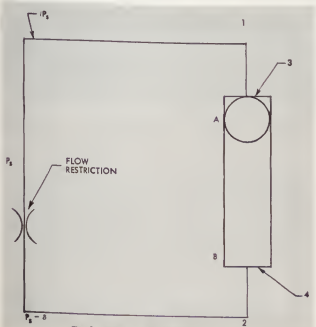


Fig. 2. Simple bi-stable circuit

-100°F to +2000°F without provision for heating or cooling. It will be free to operate in almost any radiation environment since it will have no solid state or other electronic components.

The bistable element can be packaged at approximately 3000 per cubic inch with all interconnections.

The high packaging density of pneumatic computers would allow the construction of a medium size digital computer complete with matrix memory that would occupy a volume approximately 5.5 x 5.5 x 1 inches. The assembly is packaged with module construction consisting of a stack of five perforated and two solid matrix plates. Circuit connections are made by drilling through the matrix plates at the desired positions. The plates can be manufactured from any material that can be photoetched or chemically machined.

The power consumption of the pneumatic computer is comparable to that of an electronic computer of a comparable capacity. Other advantages include: low cost and low risk of permanent damage caused by poor power supply regulation, temporary open or short circuits, or overloads on the output.

The only serious disadvantage of this computer is its relatively low speed (as compared to a fast electronic computer) for it operates in the range of 10 to 100 kc.

However, most of the speed disadvantages can be eliminated by using the computer to operate in parallel rather than in series. Several problems would be introduced into the computer at the same time thus yielding the same quantity of output in any given period of time. Another consideration is that many computer applications do not require the speed available in electronic computers and the advantages afforded by pneumatics could make their future application very attractive. Information for writing this paper was obtained from Kearfott Division of General Precision, Inc. and Electromechanical Design.

CAMPUS NEWS

ASCE

At the March meeting of the ASCE, Bill Pryor was elected as the representative to the Engineers' Council. Following a discussion of a proposed field trip to be held in April, two movies were shown -- "New Shapes In Concrete" and "Concrete In The Sixties."

IEEE

Professor C. D. Ferris presented a talk to the IEEE on "Biomedical Electronics" which included a discussion of the techniques used to determine the rate of blood flow and the dangers involved in being near high power radio frequency radiation. Professor Ferris concluded the interesting lecture with a demonstration of several instruments used in biomedical studies. At the business meeting Judith Popowsky was elected as the IEEE representative to the Engineers' Council for the year 1963-64.

ASME

The ASME's opened their meeting by electing Jerry Edwards as representative to the Engineers' Council and Professor Anand as faculty advisor. The annual paper contest was held and the results are as follows: first prize of $25 to Jerry Edwards for "High Precision Solution Calorimeter", second prize of $15 to Doug Jones for "Optimum Design of Cams", and third prize of $10 was awarded to Richard Singer for his paper on "Metacentric Stability of Submerged Bodies." Jerry Edwards will represent the section at both the Washington, D. C. Area ASME meeting, March 28, and the Region III Conference April 19 and 20 at Pennsylvania State University. Members are invited to attend both meetings.

THETA TAU

This past month the brothers of Theta Tau Fraternity participated in several varied functions. On March 2, a mixer was held at the Davis-Hodgkins House to introduce the active members to the prospective pledges. At the business meeting on March 13, the fraternity announced the pledging of Stanley Barr, Millard Carr, Bill Pryor, Phil Pendleton, and Chip Young. An April meeting was planned to provide information pertaining to professional engineer's registration. In addition, Richard Singer was elected as Engineers' Council Representative from Theta Tau and final plans were made for the Pledge Banquet and Ball on March 23. The Banquet and Ball was held at the Park Arlington Motel and the pledge class celebrated the Golden Anniversary of the Presidential Press Conference with one of their own variety. But bowling afterwards? Now really, men.

SIGMA TAU

Sigma Tau held its elections at the April meeting with the following results:

President	-- William Kolb
Vice President	-- Tom McIntosh
Secretary	-- Carlos Alonso
Treasurer	-- Marvin Spivak
Historian	-- Ivan Kavrukov
Corresponding Secy.	-- John Nemechek
Engineers' Council Rep.	-- Ashok Kalelkar

After elections, plans were discussed for an initiation banquet and ball to be held on April 20.

(Continued on page 18)

"Will I find exciting, rewarding challenges at W. E.?"

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THETA TAU

MECH MISS

Anyone concerned with student activities is certain to encounter our Mech Miss for April, Linda Sennett. Linda is an Elementary Education major and is Student Activities Assistant for the university. In her spare time, Linda manages to be Student Council Vice-President and Big Sis President. She has been President of Phi Sigma Sigma Sorority and she held various other offices. Last year she was named outstanding sophomore by Mortar Board.

Linda Sennett

RELIABILITY - THE ENGINEERING CHALLENGE

by Arthur Crenshaw, Jr.

This paper is intended to introduce the young engineer to the problem of reliable performance of equipment. While it is aimed principally at electronics engineers (since the problem is most acute in this field), this does not abrogate its validity in other disciplines.

According to a current definition, reliability is "the probability that an equipment will operate without functional failure for a specified period of time and under specified conditions". In other words — "It was designed to work. How long and how well will it do so?" The implication appears to be that there is such a thing as unsatisfactory performance and that someone considers it to be a problem. Why has the reliability of equipment become a problem? Failure-free operation has never been guaranteed by any manufacturer and is not really expected by the average customer. Cars, home appliances, bridges, buildings — all fail on occasion. A quick glance in a telephone book will reveal the extent of the repair business. So why is there all of this fuss?

Suppose a manufacturer uses ten thousand tubes to make two thousand five-tube radios. The tubes have an assumed probability of failure of 0.00005 per hour of operation and, in service, the radios operate two thousand hours a year. What can be expected to happen to the original tubes? The binomial probability distribution will yield the following.

No. of Failures per Set	Probability of Occurrence	No. of Customers	Total Tube Failures
0	0.59049	1181	0
1	0.32805	656	656
2	0.07290	146	292
3	0.00810	16	48
4	0.00045	1	4
5	0.00001	0	0
	1.00000	2000	1000

If a customer is not displeased should he obtain at least six months of uninterrupted service, it is apparent that more than 99% of the customers are satisfied. Yet, there have been 1000 failures. If this same batch of tubes had been placed in a ten-thousand tube computer for the same number of operating hours, it would have operated, on the average, only two hours between failures. The impact of the failure distribution has changed. One thousand failures distributed among two thousand customers gave passable results. Almost 60% of them had no failures at all and would swear by the product. The same one thousand failures concentrated in one customer produced an intolerable situation. It is more likely that he is swearing at the product rather than by it. The producer of the computer has gained only ill-will and has certainly lost his customer and probably his reputation.

Complexity of equipment, it can be considered, is a major contributor to unreliability. It is not the only one. There is a continual pressure to advance the state-of-the-art in engineering. Equipment must perform better, must be more accurate, more sensitive, or more diversified. It must be lighter, smaller, cheaper, and operate in increasingly severe environments. All of these factors contribute, but it must be recognized, too, that there has been at least a partial abdication of engineering responsibility. It has been much too easy to shrug off poor reliability and to blame it upon cost, schedule, requirements, or similar scapegoat, or, as is more common, to ignore it altogether. Yet, some studies conducted by the military have revealed that up to 40% of all failures are directly attributable to design fault.

Just how important is the reliability problem? Again, it is necessary to have recourse to some of the military studies. One conducted

This paper by Arthur Crenshaw, Jr. is the prize winning essay of the fall Sigma Tau Fraternity pledge class. Arthur expects to receive a B.E.E. degree in June and he has been a part-time student here since 1959. He is employed by Melpar Inc. as a Technical Staff Assistant to the Reliability Department Manager. In addition, Arthur is a member of the newly formed Tau Beta Pi Chapter and he is the father of six children.

by the Navy showed that the maintenance cost of shipboard electronic equipment was twice the original cost in the first year. An Air Force study revealed that it cost ten times the original equipment cost to maintain it over a five-year period. What individual would pay twice the purchase price of his car every year to keep it in running order? Over and above the criterion of cost, at least in military applications, are such intangibles as operational readiness, defense capability, and even human lives.

With the nature and the extent of the problem known, what can the engineer do to alleviate it? First, the engineer must again assume the complete responsibility for the performance of his designs, including that in the time domain even though this discomforts him. Beyond this, the exact definition of the entire program to a reliable design will depend upon the specifications. However, there are some general guidelines which can be drawn.

The first and most difficult requirement is an inversion of thinking. The engineer, accustomed to analysis in terms of achieving successful circuit or equipment performance, must instead examine the ways in which it can fail to perform properly. From this arises the second requirement — a critical analysis of the circuit to define a failure of performance and to determine what constitutes the modes of failure of a circuit. Thirdly, determine what the modes of failure of the selected components are. Are these compatible with the circuit or will the failure stress other components? A fourth requirement is analysis of the circuit equations to determine the effect of component tolerances. This may be in terms of the worst possible case, but it is normally performed by the combining of variances. The latter is a statistical technique but it is not difficult to learn or to use. As a fifth requirement, there is stress analysis. What are the ratios of applied to rated stresses? These will include all of the electrical stresses and should certainly include the effects of all of the environmental stresses. Temperature, shock, vibration, and radiation, to name but a few of these, can produce only degradation of circuit reliability. Sixth, there are methods available to assess reliability and to improve it if it is not satisfactory. The engineer should learn and use them.

It is to be noted that much has been said of analysis. For the main part, this is not mathematical. But it is tough-minded, exacting, and thorough. Let's be realistic. It is going to take time. Fortunately, there are several benefits. First of all, the time that is lost is made up several times over in the breadboard stage of design. Secondly, the engineer will know his circuit in all of its facets. Third, the steps become more fluent with use. Finally, there is the reward of pride in good engineering.

Eventually, the circuit is going to be assembled and tested. One last note should be added to the technique. Data acquired from a test of a single sample has little to recommend it, even for engineering purposes. Statistical validity may be impractical to achieve, but small sample sizes of three to five with simple analysis will eliminate most of the gross errors which creep into design.

The entire process can best be summarized as follows. Think negatively. Know components thoroughly. Analyze the stress effects and failure modes. Test or measure results on more than one sample. Use every bit of information available. For, as the needs of a complex society grow ever more demanding, reliability will become increasingly necessary. It is the engineer's responsibility to provide what a dynamic society requires. How will you meet it?

Douglas Jones demonstrates the metals selector exhibit.

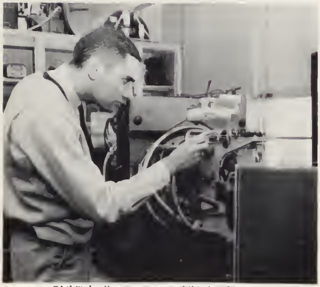
climbing to the mezzanine, the guests saw an operating model of the Corps of Engineers' latest development in land tractors. In the fluid laboratory the smoke tunnel visually illustrated the laws of fluid flow over various shapes while the wind tunnel demonstrated the effects of lift and drag. A favorite in that laboratory proved to be the hydraulic jump, a demonstration of energy dissipation in water constrained to flow in a plastic rectangular flume.

To complete their tour, the visitors were led to the main floor again where they observed International Business Machines' photographic exhibit featuring the many space ventures involving I.B.M. The FLAC computer was the next stopping place and our guests were given some insight into the growing field of computer technology. This brought the tour back to the lobby where they had the opportunity to closely examine a scale model of American Telephone and Telegraph's Telstar satellite. Also in the lobby, an Air Force exhibit depicted the various concepts of air power: manned bomber, strategic missile, and reconnaissance satellite. The final exhibit, the Navy Space Surveillance System, was a remarkable animated display depicting the tracking of a satellite by a ground screen concept. A narrow angle Radio Frequency screen is put up from five stations located across the Southern United States. Any satellite passing through this screen is immediately identified or marked for identification. In this way the SPASUR system maintains a watch over the nearly 300 objects orbiting our planet. A large screen depicted the position of several of these objects as they were <u>in real time</u>. This means that while the guests were watching any particular satellite, the device was indicating exactly the location and altitude of that satellite. This information was updated every minute in a continuous display of the object's last five positions — a fitting climax to a stimulating and interesting tour.

The Anti-submarine Warfare exhibit provided by Vitro Engineering, Inc.

The main reason for the success of this year's Open House was undoubtedly the cooperation of the students and faculty of the School of Engineering and Applied Science.

Perhaps such a spirit and associative will to work will sustain the quality of our nation's engineers until their number can be brought to its desired level.



Phil Walcoff prepares an exhibit for the big rush.

TECH NEWS

Edited by Clifford Stearns

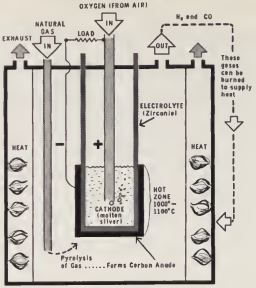
HYDROCARBON FUEL CELL—A POWER SOURCE FOR SPACECRAFT?

A step toward the long-sought goal of a practical fuel cell that will operate on inexpensive fuels such as natural gas has been demonstrated by scientists at the General Electric Research Laboratory. Fuel cells are devices that convert chemical energy directly into electrical energy without the use of moving parts. Most earlier fuel cells have operated on hydrogen, a fuel substantially higher in cost than the common hydrocarbons (natural gas, propane, coal, and gasoline). Cost factors are therefore likely to limit hydrogen fuel cells to specialty applications such as power sources for spacecraft and portable military communication systems.

This new cell operates at high temperatures and incorporates novel features for "self-starting" and for maintaining itself at approximately 2000 degrees F. without the use of externally applied heat. In addition, this cell has a solid electrolyte made of zirconia, a refractory oxide. Several of the cells have been stacked together in the form of a "fuel battery." It is estimated that the maximum efficiency of fuel batteries of this type would be in the neighborhood of 30%, using natural gas as the fuel. Greater efficiency may be possible with other hydrocarbons. By comparison, the typical internal-combustion automobile engine is about 20% efficient, large central-station power plants achieve about 40% and hydrogen fuel cells operate in the range of 50-80% efficiency.

In the new fuel cell, the natural gas breaks down into carbon and hydrogen. Carbon builds up inside the cell to form one electrode. Oxygen is obtained from air which is introduced into the other electrode (molten silver), and oxide ions migrate through the zirconia electrolyte to the carbon electrode. The oxygen yields its electrons to the carbon and combines with part of the carbon to form carbon monoxide gas. The electrons are conducted out of the cell as an electric current. To supply heat for the self-sustaining feature of the cell, the left-over carbon monoxide and hydrogen gases are burned within the cell assembly. Laboratory versions of non-self-sustaining cells have operated on natural gas and oxygen at current densities of up to 150 amperes per square foot at 0.7 volt. Similar cells on life test at lower current densities have been operated for as long as 3,000 hours without deterioration. Among the advantages of the new cell is the fact that it does not require significant quantities of expensive catalytic electrode material. The solid electrolyte also has great structural and chemical stability. One of the future applications of this cell is to provide the power source for the two-man "Gemini" spacecraft.

Principle of Operation



SCHEMATIC DIAGRAM of General Electric's new fuel cell shows natural gas being introduced at top left. The gas pyrolizes when it reaches the "hot zone" of the cell (2000°F), forming hydrogen and carbon. The carbon deposits itself on the outside of a zirconia crucible, thus forming the anode. To supply heat, the hydrogen, together with carbon monoxide that is also formed in the cell, can be burned within the cell assembly. The zirconia crucible serves as a solid electrolyte and contains a small quantity of molten silver, in which oxygen from the air supplied to it is continuously dissolving. Oxygen ions move out of the molten silver carrying two electrons each through the zirconia electrolyte, then combine with the carbon anode, forming the carbon monoxide mentioned above and releasing the electrons. The electrons are conducted out of the cell as an electric current.

LATEST IN THE STRUCTURE OF NUCLEAR PARTICLES

Is all matter really made up of only a few basic particles instead of the 30 or more different "pieces" now assumed to compose it? At one time scientists thought so. But this was before the host of new atomic particles, and antiparticles, discovered in recent years through large-scale atom-smashing experiments. These new, heavy, short-lived particles—called mesons and hyperons—now account for most of the known entities linked to the atom's nucleus. All of them have average lifetimes of less than a millionth of a second. They have so complicated the originally simple concept of the atom that many physicists believe that matter cannot be as complex as it now appears and are seeking simpler explanations of its structure. Such a unifying concept was proposed in a paper recently presented to the American Physical Society by Dr. E. J. Sternglass, advisory physicist at the Westinghouse Research Laboratories, Pittsburgh, Pa. Dr. Sternglass suggested that two familiar, lightweight particles — the electron and its positively charged counterpart, the positron — may be the building blocks from which mesons are put together. These heavy, unstable mesons, he said, can be explained as pairs of positively charged and negatively charged electrons, arranged in various combinations, but always in high-speed rotation according to the principles of relativity theory.

(Continued on next page)

Single Electron Pair is Basic Grouping

The simplest grouping is a single electron-positron pair, whirling around at nearly the speed of light in a tiny orbit about 100,000 times smaller than the diameter of a hydrogen atom. This simple system, is shown to have the basic properties of the so-called neutral pi meson including its mass, decay behavior, lifetime, size, spin and parity. This meson is considered a key particle in explaining nuclear structure. It is thought to be present in the nucleus of the atom, where it supplies the "glue," or nuclear force, which holds the nucleus together. Dr. Sternglass' paper extends this earlier work in two important respects: (1) it explains this nuclear force as arising between electron-positron pairs (pi mesons), and (2) it then extends the electron-positron pair concept to other nuclear particles.

Dr. Sternglass explains the great strength of the nuclear force by the extremely high velocities and close spacings of the electron and positron in the pi-meson system. These charges, moving at extreme speeds, create very strong magnetic fields, which can attract a similar system only at close range. This force, however, is some 500 times stronger than the attraction of similar charges at rest. Nuclear forces thus would be understandable in terms of ordinary electromagnetic attraction, analogous to the forces that bond molecules together. Once the nature of the forces is established, it is possible to construct systems of two or more electron-positron pairs and to compare them with the newer, heavier mesons. The simplest such system (two electron pairs or two pi mesons) mathematically accounts for the masses and internal spins of two additional mesons, the K meson and rho meson.

Additional Heavy Particles Predicted

Other systems, made up of three, four and five electron-positron pairs, similarly account for the masses of all the recently discovered heavy mesons to within a few percent of their observed values. In addition, other more energetic mesons are predicted and should be observed experimentally when more powerful atom-smashing experiments are performed. Finally, by combining electron-positron pairs with the proton as a nuclear building block, the properties of hyperons — unstable particles which break up into mesons and protons — can be explained. Throughout the calculations, relativistic motion of the basic electrons and positrons is assumed. The theory of relativity dictates that the mass of an object increases with its velocity. Under normal conditions the effect is negligible. But moving at speeds near the velocity of light, the electron and positron increase in mass some 274 times. Of all known particles, electrons and positrons have unique qualifications that suggest their choice as fundamental particles: stability, sameness, and indivisibility. They are stable even under bombardment from cosmic rays and the largest atom smashers; they always have the same properties under the same physical conditions; and they have never been found to break apart into smaller fragments. When they do disappear, they vanish together as a whole, with all their mass converted into radiation.

FRANK HOWARD AWARDS

At the Frank Howard Lecture, on February 19, several awards were presented by Engineering Alumni Association President Thomas Creswell.

Distinguished Alumnus — Dean Martin A. Mason

Outstanding graduating students:

Civil Engineering	— Fred Hood
Electrical Engineering	— Donald Miller
Mechanical Engineering	— Douglas Jones
B. S. in Engineering	— Lee Kaminetzky

Dean Martin A. Mason is shown receiving the Distinguished Alumnus Award at the Frank Howard Lecture. The award was presented by Thomas Creswell, President of the Engineering Alumni Association.

Following the presentations, Dean Mason presented the Frank Howard Lecture entitled "Some Things Old - Some Things New!" Dean Mason presented a brief resumé of engineering education since its beginning and then spoke on the ramifications of the new curriculum.

ENGINEERS' COUNCIL

On March 13 and 14 an election was held for the position of Senior Class representative to the Engineers' Council, while the elections of the other four class representatives went uncontested. Freshman representatives will be chosen next September. For the year 1963-64, the Engineers' Council is as follows:

Senior	Bob Millard	OL 4-3878
Senior	Ragnu Chari	EM 2-5673
Junior	Philip Kaplan	RA 3-4457
Junior	Vytas Tarulis	LU 4-9713
Sophomore	John Starke	537-0123
Sophomore	Chip Young	534-0960
ASCE	Bill Pryor	JE 3-4317
ASME	Jerry Edwards	337-1897
IEEE	Judy Popowsky	RA 6-8458
Theta Tau	Richard Singer	JO 2-5364
Sigma Tau	Ashok Kalelkar	OL 6-2082
Tau Beta Pi	Carlos Alonso	LA 6-7063

INTRAMURALS

This past month saw the close of the basketball season. Playing regularly for the Engineering School were Paul Fleming, Orville Standifer, John Jenkins, Dick Singer, Richard Perlut, and Tom Nivert. In April, a track meet will be held. Also, it is hoped that enough people will sign up to have a team for the approaching softball season. Those interested in either track or softball should watch for a notice on the bulletin board.

STOP ! ! !

APRIL 19

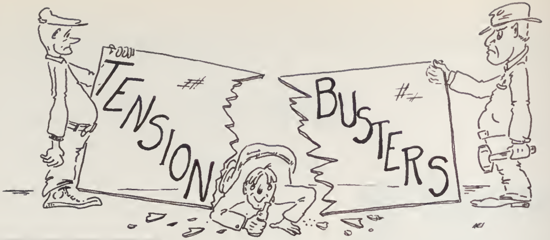
1:00 P.M.

ROOM 200

THE PREMIER OF THE
STUDENT-FACULTY FORUM

TO CONTINUE ON A WEEKLY BASIS
THIS SPRING

INDEX TO ADVERTISERS



Oh, hail to thee, tiny insect so small,
Swimming around in my bourbon highball.
Back-stroking, breast stroking, movement of wing,
Now up on the ice cube, poor cold little thing.

If you stay there too long, you'll find with remorse,
your ankles will numb and your buzz will get hoarse.
Catching cold is unpleasant for all little flies,
And Bloodshot is gruesome for multiprism eyes.

Some people hate flies, take my old cousin Sam.
He gets in a snit when you sit in his jam.
I've seen sister Sally turn red as a beet
When you walk on her nose with your six sticky feet.

When you walk on the ceiling, your brow seems to frown.
Does blood go to your head, when you stand upside down?
My optometrist friend, a dear boy named Rex,
Makes bifocals for flies: he calls them "fly specs".

Now You're coughing because you're so full of troubles!
Or is it the bourbon that's making you bubble?
You should get off the ice, the temperature's minus.
You'll get frost in your naval, and a wee touch of sinus.

by the Late Ernie Kovacs

* * *

A well qualified and thoroughly honest woman lost out on a job when she gave her correct age — thirty eight — on her application. She did learn a lesson, however, because on the next employment application she filled out, she wrote under "Age": "I refuse to answer the question on grounds that it might tend to eliminate me".

A laboratory monkey was returned to his natural habitat after flying three orbital missions. Almost immediately, he was set upon by a predatory female who would tease him and cajole him. Completely ignorant to the ways of life, he would search his mind to find a meaning to her behavior. He finally found the answer when one day the female became so incensed at him that from the highest tree she hurled a coconut that came crashing on his head. "Aha," said he, "Now I know, F = MA." (See Cover)

* * *

Asked to what he attributed his long life, the old codger said: I can't tell you right now. You see, I am still dickering with two different patent medicine companies and a breakfast food concern".

* * *

The difference between frustration and panic is that frustration is the feeling you have the first time you discover you can't do it the second time, while panic is the way you feel the second time you find out you can't do it the first time.

* * *

Seventy six percent of the body is pure water, but there are many who seize every opportunity to change their percentage. One of these, a CE, was staggering along the sidewalk, when he lost his balance and fell — but in a sitting position. As he hit the pavement he heard the sound of a bottle breaking. Scrambling to his feet, he felt his backside. It was definitely wet. Slowly, he brought his hand around before his eyes, as he prayed, "Dear God, let it be blood".

* * *

The convicted murderer was given the choice of electrocution or the gas chamber.

"Oh, not gas" said he. "Gas always makes me sick afterward".

A slightly inebriated ME went to get a haircut. After the barber was finished he held a mirror behind the ME's head and asked, "Is it OK?" The ME gazed into the mirror before him and said, "Just a little longer in back, please".

* * *

The headshrinker was appalled at the condition of his patient and told him so.

"Doc," said the patient, "I know why I came here bombed. Don't think I don't."

The headshrinker was pleased. "Tel me, why?"

"Because I ran out of money, that's why".

* * *

Two seniors were discussing girls (what else). The fat one said, "I had a date with Josie Doakes last night. I took her to dinner, a show, and then we went dancing. And after all that, do you know what she said?"

"No," said the thin one.

"Oh," answered the fat one, "then you've taken her out too."

* * *

"I suppose you and your husband worry a great deal because you haven't any children?" the doctor said to his distraught patient.

"Oh, yes," was the reply, "we spend many a sleepless night over it."

* * *

We know of a falsie manufacturer who lives off the flat of the land.

* * *

It was Adam who supplied the parts for the first electronic device. From him we got the first squawk box.

An interview with General Electric's W. Scott Hill

One of a series . . .

Manager—Engineering Recruiting

How to Make the Most of Your First Five Years

MR. HILL has managerial responsibility for General Electric's college recruiting activities for engineers, scientists, PhD's and technicians for the engineering function of the Company. Long active in technical personnel development within General Electric, he also serves as vice president of the Engineers' Council for Professional Development, board member of the Engineering Manpower Commission, director of the Engineering Societies Personnel Service and as an officer or member of a variety of technical societies.

Q. Mr. Hill, I've heard that my first five years in industry may be the most critical of my career. Do you agree?

A. Definitely. It is during this stage that you'll be sharpening your career objectives, broadening your knowledge and experience, finding your place in professional practice and developing work and study habits that you may follow throughout your career. It's a period fraught with challenge and opportunity—and possible pitfalls.

Recognizing the importance of this period, the Engineers' Council for Professional Development has published an excellent kit of material for young engineers. It is titled "Your First 5 Years." I would strongly recommend you obtain a copy.*

Q. What can I do to make best use of these important years?

A. First of all, be sure that the company you join provides ample opportunity for professional development during this critical phase of your career.

Then, develop a planned, organized personal development program—tailored to your own strengths, weaknesses and aspirations—to make the most of these opportunities. This, of course, calls for a critical self appraisal, and periodic reappraisals. You will find an extremely useful guide for this purpose in the "First 5 Years" kit I just mentioned.

Q. How does General Electric encourage self development during this period?

A. In many ways. Because we recognize professional self-development as a never-ending process, we encourage technical employees to continue their education not only during their early years but throughout their careers.

We do this through a variety of programs and incentives. General Electric's Tuition Refund Program, for example, provides up to 100% reimbursement for tuition and fees incurred for graduate study. Another enables the selected graduate with proper qualifications to obtain a master's degree, tuition free, while earning up to 75% of his full-time salary. These programs are supplemented by a wide range of technical and nontechnical in-plant courses conducted at the graduate level by recognized Company experts.

Frequent personal appraisals and encouragement for participation in professional societies are still other ways in which G.E. assists professional employees to develop their full potential.

Q. What about training programs? Just how valuable are they to the young engineer?

A. Quite valuable, generally. But there are exceptions. Many seniors and graduate students, for example, already have clearly defined career goals and professional interests and demonstrated abilities in a specific field. In such cases, direct placement in a specific position may be the better alternative.

Training programs, on the other hand, provide the opportunity to gain valuable on-the-job experience in several fields while broadening your base of knowledge through related course study. This kind of training enables you to bring your career objectives into sharp focus and provides a solid foundation for your development, whether your interests tend toward specialization or management. This is particularly true in a highly diversified company like General Electric where young technical graduates are exposed to many facets of engineering and to a variety of product areas.

Q. What types of training programs does your company offer, Mr. Hill?

A. General Electric conducts a number of them. Those attracting the majority of technical graduates are the Engineering and Science, Technical Marketing and Manufacturing Training Programs. Each includes on-the-job experience on full-time rotating assignments supplemented by a formal study curriculum.

Q. You mentioned professional societies. Do you feel there is any advantage in joining early in your career?

A. I do indeed. In fact, I would recommend you join a student chapter on your campus now if you haven't already done so.

Professional societies offer the young engineer many opportunities to expand his fund of knowledge through association with leaders in his profession, to gain recognition in his field, and to make a real contribution to his profession. Because General Electric benefits directly, the Company often helps defray expenses incurred by professional employees engaged in the activities of these organizations.

Q. Is there anything I can do now to better prepare myself for the transition from college campus to industry?

A. There are many things, naturally, most of which you are already doing in the course of your education.

But there is one important area you may be overlooking. I would suggest you recognize now that your job—whatever it is—is going to be made easier by the ability to communicate . . . effectively. Learn to sell yourself and your ideas. Our own experience at General Electric—and industry-wide surveys as well—indicates that the lack of this ability can be one of the major shortcomings of young technical graduates.

**The kit "Your First 5 Years," published by the Engineers' Council for Professional Development, normally sells for $2.00. While our limited supply lasts, however, you may obtain a copy by simply writing General Electric Company, Section 699-04, Schenectady, New York.*

(An equal opportunity employer.)

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GENERAL ELECTRIC